FIDS 89-6

# Forest Insect and Disease Conditions

## Vancouver Forest Region
## 1988

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## APPENDICES

The following appendices are available upon request from the Forest Insect and Disease Survey, Forestry Canada, 506 West Burnside Road, Victoria, B.C. V8Z 1M5.

I. Canadian Forestry Service, Forest Insect and Disease Survey, Seed Orchard Examination Report Summary - 1988.

II. Forest Pest Conditions in Pacific Rim National Park, 1988.

III. Forest Pest Conditions on the Gulf Islands, 1988.

IV. Pest Conditions at Mt. Maxwell Eco Reserve, 1988.

V. Forest Pest Conditions at Carnation Creek, 1988.

VI. Forest Pest Conditions at Shawnigan Experimental Plots, 1988.

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VIII. Status of Forest Pests in Provincial Parks in the Vancouver Forest Region, 1988.

IX. Status of Forest Pests in the Vancouver Watersheds, 1988.

## INTRODUCTION

This report outlines the status of forest pest conditions in the Vancouver Forest Region for 1988 and forecasts population trends of some potentially damaging pests. Pests are listed by host in order of importance.

The Forest Insect and Disease Survey (FIDS) is a nation-wide network within Forestry Canada with the responsibility of producing an overview of forest pest conditions and their implications; maintaining records and surveys to support quarantine and facilitate predictions; supporting forestry research with records, insect collections and herbaria; providing advice on forest insect and disease conditions; developing and testing survey techniques; and conducting related biological studies.

The Queen Charlotte Islands were surveyed by Prince Rupert FIDS Ranger Al Stewart, insect and disease data from the mid-coast forest district was collected by Bob Erickson, the Cariboo FIDS Ranger.

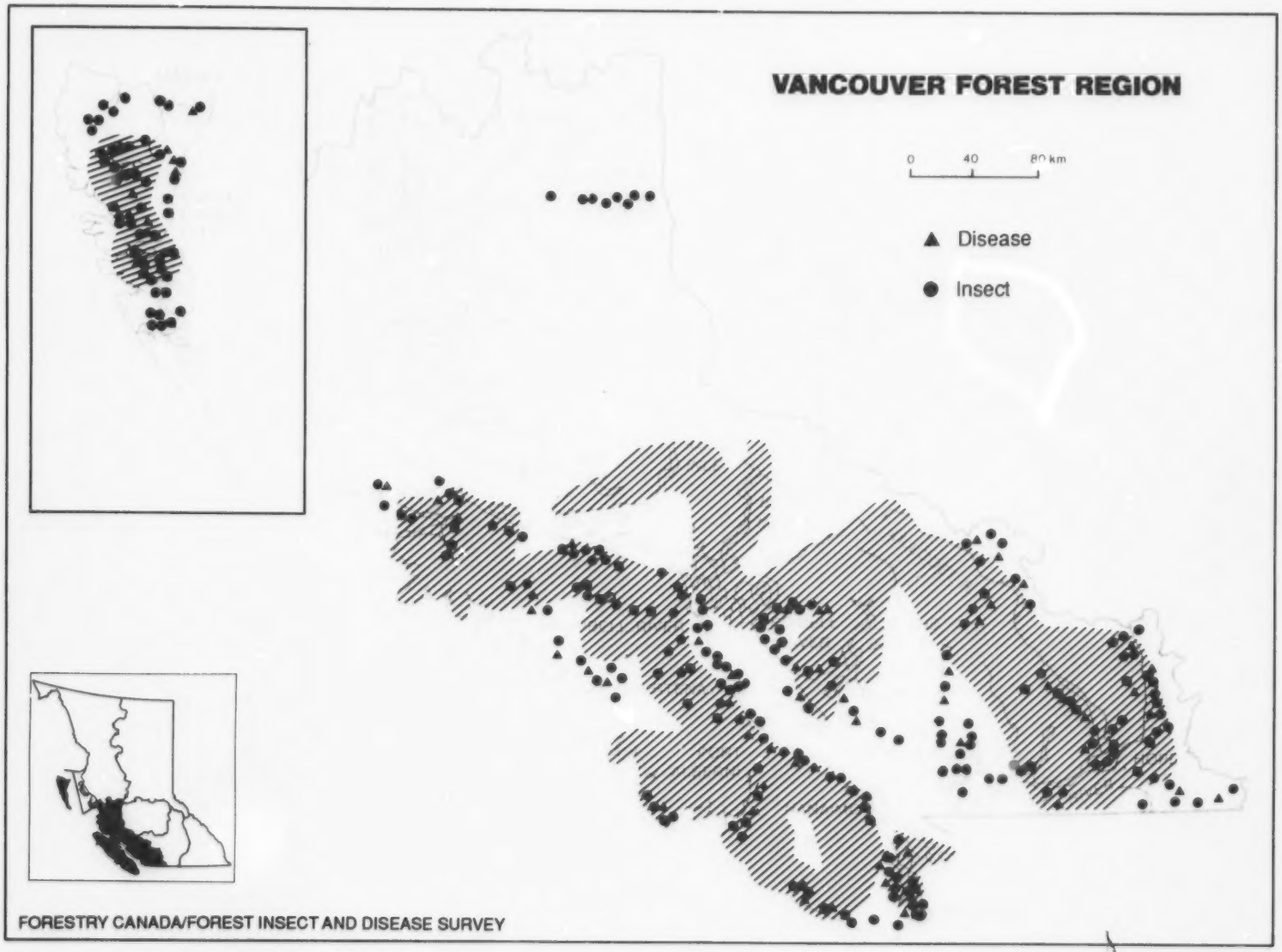
The forest pest survey field season extended from mid-May to early October. A total of 608 insect and 187 disease collections were submitted to Pacific Forestry Centre by FIDS survey personnel. Map 1 shows the locations where one or more samples were collected and the areas covered by 21 hours of fixed-wing aircraft surveys and 2 hours of helicopter surveys. A total of 32 special collections included spruce budworm parasites, satin moth, hemlock sawfly, blackheaded budworm, dogwood leaf blight, Armillaria root rot, and diseases and insects of weed species.

Numerous special surveys were conducted including: pinewood nematode, inspections of provincial parks and seed orchards, acid rain plot monitoring, spruce budworm and gypsy moth pheromone trapping, young stand surveys, Rhizina and Armillaria root disease surveys, European pine shoot moth quarantine surveys, Sitka spruce provenance trials and fume damage plot assessment.

Personnel of the B.C. Forest Service (BCFS), MacMillan Bloedel Ltd., and Western Forest Products Ltd. assisted with ground and air transportation, and with defoliator larval and egg sampling.

Defoliation intensities in the report are defined as follows:

Trace - evidence of feeding barely detectable close up
Light - some branch and/or upper crown defoliation, barely visible from the air
Moderate - pronounced discoloration and noticeably thin foliage, severe top defoliation common
Severe - top + many branches completely defoliated, most trees more than 50% defoliated




Map 1. Locations where one or more forest insect and disease samples were collected and areas covered by aerial surveys to map bark beetle and defoliator infestations in 1988.

## SUMMARY

**Western spruce budworm** lightly to moderately defoliated Douglas-fir over 3640 ha in the Birkenhead Lake-Blackwater Creek area, up from 2850 ha in 1987. For the fourth consecutive year **Douglas-fir beetle** attacks decreased, infesting trees over 37 ha. **Cone and seed pests** infested an average 12% of the Douglas-fir cones from nine of the 13 seed orchards surveyed in the region.

**Mountain pine beetle** killed an estimated 20 000 lodgepole pine over 845 ha in 68 infestations, a decrease from 55 500 trees over 1470 ha in 101 infestations in 1987. **Pine needle sheathminer** defoliated immature pine for the third consecutive year in the Vancouver Region. **European pine shoot moth** was found at four of 13 sites surveyed. Ten chip piles were surveyed for the presence of **pinewood nematode** vectors; results were negative.

The **lodgepole pine cone borer** severely infested cones for the second year on the Queen Charlotte Islands. Immature lodgepole pine were severely infested by **pine needle cast** throughout Manning Park.

For the fourth consecutive year some **blackheaded budworm**, but mostly **hemlock sawfly**, defoliated western hemlock on the Queen Charlotte Islands, covering 7 360 ha, down from 14 110 in 1987. The **blackheaded budworm** alone defoliated western hemlock over an estimated 4830 ha on northern Vancouver Island. The **western hemlock looper** infestation recorded last year over 90 ha at Jervis Inlet collapsed. A **shoot blight** caused widespread shoot defoliation of western hemlock over a large part of the host range.

The **balsam bark beetle** killed an estimated 9440 alpine fir over 470 ha compared to 10 450 trees over 420 ha in 1987. The **fir engraver beetle** in conjunction with drought was responsible for killing numerous grand fir in southwestern British Columbia. The spread of **balsam woolly adelgid** appears static and inside the quarantine zone.

**Spruce beetle** infested an estimated 84 ha of Engelmann spruce in Manning Park. **Spruce weevil** caused an average 32% leader mortality of Sitka spruce at 13 locations. Defoliation of spruce trees by the **green spruce aphid** continued at slightly decreased levels in the region. The **cone midge**, **fir coneworm** and the **spruce maggot** infested 2.7% of spruce cones on the Queen Charlotte Islands. A **spruce needle rust** and a **spruce needle cast** infected Sitka spruce at several locations on Graham Island.

The **redwood bark beetle** attacked drought-stressed western red cedar over a wide area in southwestern British Columbia. The incidence of **gall midge** on yellow cedar increased dramatically on southern Vancouver Island.

A total of 21 natural and planted stands were surveyed for pest problems, some of which were **deer browse**, **pine needle sheathminer** and **white pine blister rust**. **Gypsy moth** pheromone-baited sticky traps were placed at 97 locations; a total of seven gypsy moths were trapped by Agriculture Canada in the region. The **root collar weevil** caused moderate levels of conifer mortality at two locations on Vancouver Island. **Drought**-caused mortality and top-kill of conifers was widespread in coastal areas. **Satin moth** in conjunction with the **forest tent caterpillar** severely defoliated exotic poplar over approximately 200 ha

southwest of Chilliwack. Populations of the **western tent caterpillar** have declined to endemic levels after four consecutive years of severe defoliation. Defoliation by the **winter moth** continued for the eighteenth consecutive year throughout southern Vancouver Island. The **western winter moth** defoliated an estimated 110 ha of vine and broadleaf maples throughout Sasquatch Park. The **alder sawfly** defoliated red alder over a wide area on the Queen Charlotte Islands. Western flowering dogwood was severely defoliated by **dogwood leaf blight** throughout the host range.

Thirteen seed orchards were surveyed two or more times for early detection of pests, some of which were **balsam woolly adelgid**, **Cooley spruce gall adelgid** and **Douglas-fir cone moth**. Foliage discoloration caused by **fume damage**, covering an estimated 34 ha and previously noted cumulative damage, i.e. dead snags, over 300 ha were visible near Port Alice. Numerous insects and diseases and some possible **acid rain** symptoms were recorded at some of the 10 ARNEWS (Acid Rain National Early Warning System) study plots in the region. Collections and records were made of many pests currently at endemic levels, i.e. **green-striped forest looper**, **western gall rust**, **spruce budmoth** and **phantom hemlock looper** and have been listed in the table of minor pests. New records of occurrence and distribution of pests have also been included in this report.

## DOUGLAS-FIR PESTS

### Western spruce budworm
### *Choristoneura occidentalis*

The western spruce budworm lightly to moderately defoliated 3640 ha of mature and immature Douglas-fir in the Vancouver Region in 1988 (Map 2), up from 2850 ha in 1987.

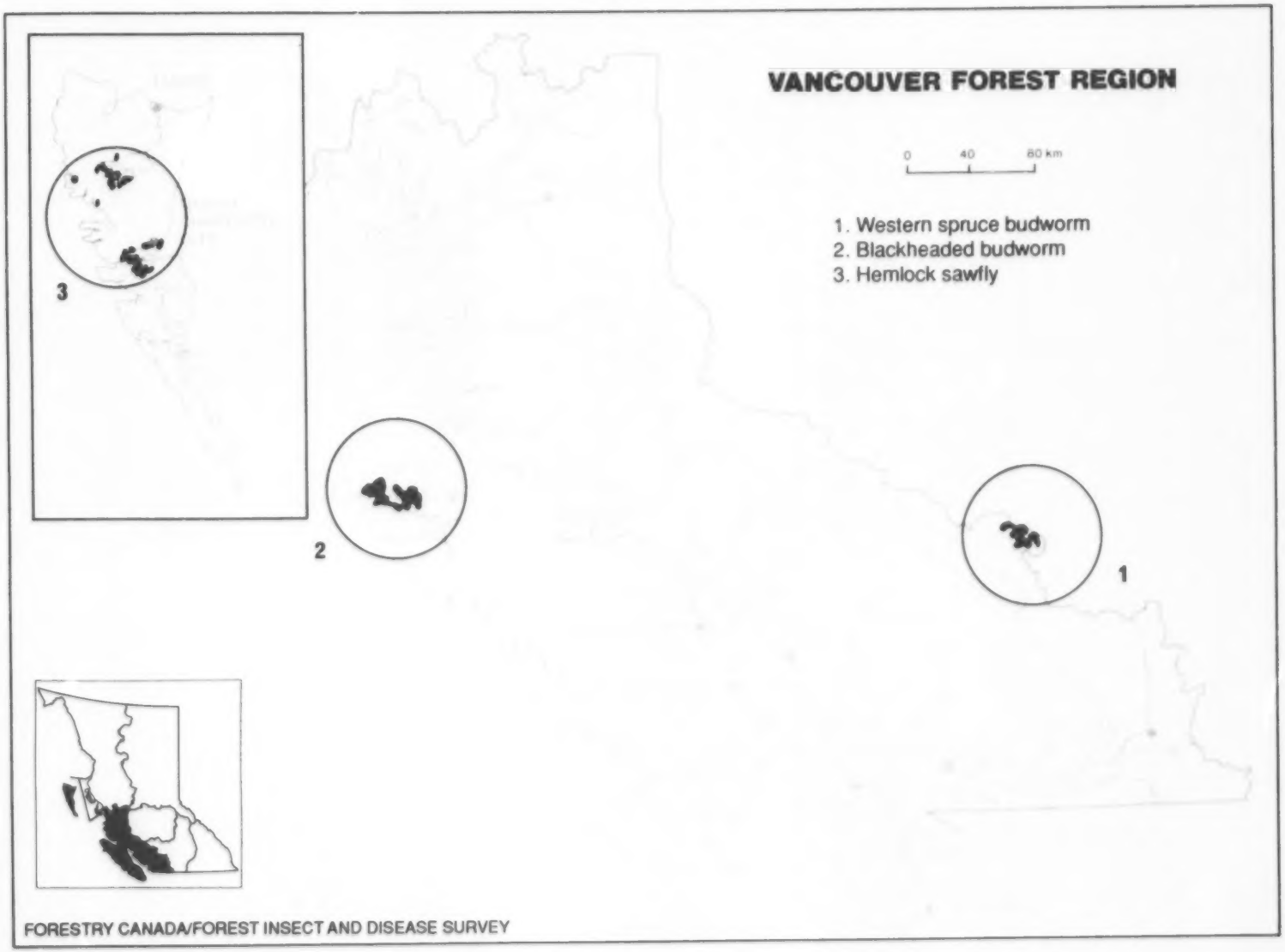
Defoliation expanded to the west from the Blackwater Creek drainage into the Phelix Creek and Sockeye Creek drainages. Budworm feeding continued over approximately the same area and at the same intensity as 1987 in the Blackwater Creek and Haylmore Creek drainages (Table 1). The budworm caused light defoliation over 1330 ha in 14 infestations and 2310 ha of moderate defoliation in nine infestations.

Table 1. Location, area and intensity of Douglas-fir defoliation by western spruce budworm, as determined from aerial surveys, Vancouver Forest Region, 1988.

| TSA and Location | Area of defoliation (ha) | | | |
|---|---|---|---|---|
| | Light | Moderate | Severe | Total |
| SOO TSA | | | | |
| N. Blackwater Creek | 390 | 820 | - | 1210 |
| S. Blackwater Creek | 170 | 890 | - | 1060 |
| Haylmore Creek | 360 | | - | 360 |
| Gates River | | 180 | - | 180 |
| Phelix Creek | 410 | 420 | - | 830 |
| Total | 1330 | 2310 | - | 3640 |

Scattered mortality of understory Douglas-fir was noted in the Haylmore Creek and Blackwater Creek drainages with an estimated 3% of the trees killed. Top-kill of mature Douglas-fir, affecting approximately 5% of the trees, was also noted in the Scout Creek and Blackwater Creek drainages. Based on previous outbreaks, mortality and top-kill will probably increase over the next few years even after the infestation subsides.

Egg mass collections made during September at seven locations within infested areas averaged 57 egg masses/10 $m^2$ of foliage, range 12-148, down 32% from an average of 84, range 18-156, in 1987 (Table 2). The number of egg masses decreased by an average of 62% in four out of five locations sampled in 1987. The decreases occurred in areas where the budworm has been active for three consecutive years. Devine was the only site which showed an increase, from 18 to 32 egg masses. Egg counts at two areas where no defoliation was evident in 1987, Phelix and Sockeye creeks, were 148 and 56, respectively. Budworm populations seem to be increasing in new areas but decreasing in areas




Map 2. Areas where current defoliation was detected during ground and aerial surveys in 1988.

which have had active populations for several years, this follows the pattern of previous infestations.

Table 2. Location, average number of western spruce budworm egg masses collected, increase/decrease and predicted defoliation for 1989, Vancouver Forest Region, 1988.

| Location | Avg. no. of egg masses/10 $m^2$ of foliage/plot 1987 | 1988 | Percent increase/ decrease | Defoliation 1988 | 1989 (predicted)* |
|---|---|---|---|---|---|
| S. Blackwater Cr. | 156 | 35 | -78 | light-moderate | light |
| N. Blackwater Cr. | 140 | 99 | -29 | light-moderate | moderate |
| Devine | 18 | 32 | +43 | light | light |
| S. Haylmore Cr. | 55 | 19 | -65 | light | light |
| N. Haylmore Cr. | 49 | 12 | -76 | light | light |
| Phelix Cr. | - | 148 | new | - | moderate |
| Sockeye Cr. | - | 56 | new | - | moderate |
| Average | 84 | 57 | -41 | | |

*1-50 egg masses/10 $m^2$ - Light defoliation: discolored foliage barely visible from the air, some branch tip and upper crown defoliation.

51-150 egg masses/10 $m^2$ - Moderate defoliation: pronounced discoloration, noticeably thin foliage, top third of many trees severely defoliated, some completely stripped.

151+ egg masses/10 $m^2$ - Severe defoliation: bare branch tips and completely defoliated tops, most trees more than 50% defoliated.

Larval parasitism by Diptera was 6.0% and 6.8% and parasitism by Hymenoptera was 38.8% and 34.2% at Blackwater and Haylmore creeks, respectively, for an overall average of 42.9% of the budworm parasitized. This is a dramatic increase from 1987 when only 9.2% of the larvae were affected. This increase in larval parasitism is partially responsible for the decrease in budworm populations at certain locations.

A pheromone-baited trap calibration project, started in 1987 to detect increasing budworm populations, was continued in 1988. Multipher traps (5/site) were placed in each of four areas of previous infestations in the Vancouver Region, Devine, Skagit Valley, North Bend and Anderson River drainage (Table 3).

Table 3. Location, number larvae/tree, number of adult male moths/trap and degree of defoliation at four spruce budworm pheromone calibration plots in the Vancouver Forest Region, 1988.

| Location | Avg. no. larvae/tree | | Avg. no. moths/trap | | Total tree defoliation at plots | |
|---|---|---|---|---|---|---|
| | 1987 | 1988 | 1987 | 1988 | 1987 | 1988 |
| Devine | 4.8 | 17.4 | 780 | 677* | trace | light |
| North Bend | 0 | .04 | 19.3 | 25.2 | none | none |
| Anderson River | .2 | .2 | 21.2 | 6.0 | none | none |
| Skagit Valley | 0 | .04 | 0 | 1.0 | none | none |

*Two traps destroyed at this location, average of three traps.

At Devine there was a 13% decrease in the number of moths despite a fourfold increase in the number of larvae. Heavy larval parasitism could be responsible. Several years of sampling and trapping will be required before any conclusions can be reached and, hopefully, larval levels and defoliation predicted from the moth catches.

## Douglas-fir beetle
## *Dendroctonus pseudotsugae*

The area of Douglas-fir beetle attacks decreased for the fourth consecutive year in the Vancouver Region. In 1988, 37 ha of beetle-attacked trees were mapped compared with 42 ha, 55 ha, 156 ha and 235 ha in 1987, 1986, 1985 and 1984, respectively.

Small groups of one to three mature Douglas-fir killed by the beetle in the Fraser Canyon occurred between North Bend and Nahatlatch Lake. These trees were probably weakened by overmaturity and root disease. This area has a long history of scattered beetle-related tree mortality. Larger areas of up to 6 ha were recorded in the Anderson River and Emory Creek drainages. Beetle populations and attacks are expected to remain at low levels for 1989.

## Cone and seed pests

Heavy cone crops were recorded in the Vancouver Forest Region in 1988. While no Douglas-fir cone collections were made from natural stands, cone and seed pests infested an average 12%, range 0-30%, of the cones from nine of the Vancouver Region seed orchards, compared with 4%, range 0-100%, in 1987 (Table 4). Collections consisted of 25 cones/tree species at each seed orchard.

The percentage of cones infested by the major insects, Douglas-fir cone gall midge, *Contarinia oregonensis*, Douglas-fir cone moth, *Barbara colfaxiana*, and Douglas-fir seed chalcid, *Megastigmus spermotrophus*, decreased to 5%, 4% and 1% from 29%, 13% and 7% in 1987, respectively. The sometimes damaging fir coneworm, *Dioryctria abietivorella*, also decreased to 4% from 14%. The percentage of cones infested by Douglas-fir cone scale midge, *Contarinia washingtonensis*, the least damaging of the five cone insects remained constant at 2%. Monitoring will continue in 1989.

Table 4. Incidence of Douglas-fir cone and seed pests, Vancouver Forest Region, 1988.

| Seed orchard | Percent cones infested by pest | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Contarinia oregonensis[1] | | Barbara colfaxiana[1] | | Megastigmus spermotrophus[1] | | Dioryctria abietivorella[2] | | Contarinia washingtonensis[3] | | Total | |
| | 1987 | 1988 | 1987 | 1988 | 1987 | 1988 | 1987 | 1988 | 1987 | 1988 | 1987 | 1988 |
| Mt. Newton | 25 | 0 | 0 | 5 | 0 | 0 | 0 | 15 | 0 | 0 | 25 | 20 |
| Quinsam | 30 | 15 | 20 | 5 | 20 | 5 | 15 | 0 | 10 | 5 | 80 | 30 |
| Snowdon | 90 | 0 | 45 | 0 | 15 | 0 | 55 | 0 | 0 | 5 | 100 | 5 |
| Saanich | 0 | 18 | 0 | 2 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 25 |
| Saanichton | * | 0 | * | 5 | * | * | * | 5 | * | * | * | 10 |
| Koksilah | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| Harmac | * | 5 | * | 10 | * | 0 | * | 5 | * | 5 | * | 25 |
| Sechelt | * | 5 | * | 10 | * | 0 | * | 5 | * | 0 | * | 20 |
| Nootka | * | 0 | * | 0 | * | 0 | * | 0 | * | 0 | * | 0 |
| Average | 29 | 5 | 13 | 4 | 7 | 1 | 14 | 4 | 2 | 2 | 41 | 12 |

[1]major and destroying pest
[2]can be a major pest
[3]not a major pest

*not sampled

## PINE PESTS

### Mountain pine beetle
### *Dendroctonus ponderosae*

Mountain pine beetle killed an estimated 20 000 lodgepole pine over 845 ha in 68 infestations in 1988, a decrease from 55 500 trees over 1470 ha in 101 infestations in 1987 (Table 5). Volume loss was 15 000 $m^3$, a more than twofold reduction from the 38 800 $m^3$ lost in 1987 (Map 3). This decrease follows the general declining trend occurring in most areas of British Columbia.

Table 5. Location, area, number and volume of pine trees recently killed by mountain pine beetle as determined from aerial and ground surveys, Vancouver Forest Region, 1988.

| TSA | Area (ha) | | No. of trees killed | | Vol. ($m^3$) killed | | No. of infestations | |
|---|---|---|---|---|---|---|---|---|
| | 1987 | 1988 | 1987 | 1988 | 1987 | 1988 | 1987 | 1988 |
| Fraser | 85 | 95 | 2 100 | 2 300 | 1 500 | 1 650 | 7 | 5 |
| Soo | 565 | 665 | 25 200 | 16 600 | 17 600 | 11 950 | 60 | 58 |
| Sunshine Coast | 820 | 85 | 28 200 | 2 000 | 19 700 | 1 400 | 34 | 5 |
| Total | 1 470 | 845 | 55 500 | 20 900 | 38 800 | 15 000 | 101 | 68 |

For the third consecutive year the percentage of currently attacked trees has decreased, with an average 3% for 1988, down from 12% and 19% in 1987 and 1986, respectively (Table 6). Surveys to monitor this pest will continue in 1989.

Table 6. Status of lodgepole pine stands infested by mountain pine beetle, Vancouver Forest Region, 1988.

| Location | Damage category | | | | |
|---|---|---|---|---|---|
| | H | C | R | G | P* |
| | percent of trees | | | | |
| Tenas Creek | 28 | 0 | 15 | 55 | 2 |
| Birkenhead Lake | 54 | 4 | 5 | 32 | 5 |
| S. Sockeye Creek | 37 | 5 | 20 | 34 | 4 |
| N. Sockeye Creek | 36 | 3 | 13 | 31 | 7 |
| Average | 40 | 3 | 14 | 39 | 4 |

*H - healthy; C - current, attacked in 1988; R - red, attacked in 1987; G - grey, attacked in or before 1986; P - partial attack

Map 3. Areas of lodgepole pine recently killed by mountain pine beetle determined by aerial and ground surveys in 1988.

Fraser TSA

In the Fraser TSA the volume of recently killed lodgepole pine increased slightly by 10% to 1650 $m^3$ and the area by 12% to 95 ha in 1988. The increase occurred between Yale and Boston Bar (from 40 to 60 ha), remained constant in the Hope area at 35 ha, and decreased from 10 ha to none south of Lytton.

Soo TSA

The area of attack in the Soo TSA increased by 100 ha to 665 ha and volume decreased by 32% to 11 950 $m^3$ in 1988. The apparent discrepancy in the increase in area and decrease in volume is due to a reduced intensity of attack, with the average number of current attacked trees falling to 3% in 1988 from 14% in 1987. The increase in area occurred along the east side of Lillooet Lake between Rogers Creek and Joffre Creek. Mountain pine beetle-caused mortality in the Soo TSA is expected to continue to decrease in the Pemberton-Birkenhead Lake areas and increase in the southern areas due to host availability.

Sunshine Coast TSA

The largest decrease in pine beetle attack in the Vancouver Region occurred in the Sunshine Coast TSA where the area of attack decreased by 90% to 85 ha and volume of lodgepole pine killed by 93% to 1400 $m^3$. The only area of active beetle populations was in the Rasmussen Creek drainage, along the west side of the Homathko River. Decreases in the TSA can be attributed to a large wildfire and lack of host material.

## Pine needle sheathminer
## *Zelleria haimbachi*

The pine needle sheathminer caused defoliation and resultant growth loss of lodgepole pine in the Vancouver Region for the third consecutive year over 145 ha at five locations. Damage was widespread in the northern interior of the region ranging from Twin One Creek in the east to Uztlius Creek in the west. The percentage of trees attacked and severity of defoliation increased to 47% and 8% from 76% and 15% in 1987 (Table 7). Defoliation of the current year's growth ranged from 1% at Uztlius Creek to 10% at both Cartmell and Twin One creeks.

The needle sheathminer is a pest of young trees and is not known to attack trees less than four years old. This native moth of young 2- and 3-needle pines is not a rare species, but it and its damage are relatively inconspicuous unless the population is large. Parasitism plays an important role in controlling populations; the most numerous *Z. haimbachi* parasites come from the wasp families Ichneumonidae, Braconidae and Chalcididae.

Table 7. Location, area, percent trees attacked and defoliation of lodgepole pine by pine needle sheathminer in the Vancouver Region, 1988.

| Location | Area (ha) | Percent trees attacked | | Percent defoliation | |
|---|---|---|---|---|---|
| | | 1988 | 1987 | 1988 | 1987 |
| Twin One Creek | 20 | 43 | 73 | 10 | 25 |
| Cartmell Creek | 55 | 80 | 100 | 10 | 20 |
| Keefers | 15 | 38 | 60 | 3 | 5 |
| Nahatlatch River | 30 | 52 | 70 | 6 | 10 |
| Uztlius Creek | 25 | 20 | | 1 | |
| Total | 145 | | | | |
| Average | | 47 | 76 | 8 | 15 |

Populations are expected to continue their decline in 1989 as historically infestations have lasted only a few years. Young pine stands will continue to be monitored in 1989.

**European pine shoot moth**
**Rhyacionia buoliana**

Surveys of native and exotic pines for the European pine shoot moth were positive at four of 13 locations sampled in the Vancouver Region. Positive collections were found at the George Massey Tunnel in Ladner, in the East end of Vancouver, Nanaimo, and in Victoria. Of exotic pines examined, 5% of new shoots at two locations at Nanaimo, 35% at East Vancouver and 100% at Ladner were infested with larvae. This introduced insect is successfully established in these areas and a risk of spread to other parts of the province exists.

Surveys were initiated during 1988 to establish the effectiveness of the pheromone used in a United States pheromone trapping system, and to determine the status of the shoot moth, since provincial quarantine regulations lapsed in 1981. In a co-operative effort with the B.C. Ministry of Agriculture, three different pheromone baits in sticky traps were tested at six coastal and five interior sites. Because of the large variability and small sample (60 traps), trap catch results were not significantly different. The three pheromones tested averaged 12, 8 and 6 moths/trap.

Further examinations may take place in 1989 to further test the pheromones.

**Pinewood nematode**
**Bursaphelenchus xylophilus**

Quarantine-related surveys in the Vancouver Region to determine the presence of the nematode shifted emphasis this year. In previous years wood samples were collected for the extraction of nematodes. During 1988 chip piles at mills were examined to collect possible insect vectors for the extraction and identification of nematodes. Ten chip piles at separate sites were examined but

no beetles were found. In other areas of the province, 211 beetles were collected; extractions are still underway.

The possibility of export restrictions of all coniferous raw material still exists if significant populations of this pest are found. This requires ongoing pine sampling throughout B.C. in order to determine the distribution and severity of the disease and its vectors, and to obtain phytosanitary certification. The pinewood nematode was responsible for mortality of pines over large areas in Japan over the past three decades.

Detailed studies involving inoculations of over 20 species of Canadian conifers to determine their susceptibility to several pinewood nematode isolates are presently being undertaken.

### Pine needle cast
### *Lophodermella concolor*

This needle cast severely infected immature lodgepole pine throughout Manning Park. An average of 90% of the 2-year-old needles were infected on all immature lodgepole pine from Lightning Lakes to Eastgate. This disease of moist conditions is a serious problem on young or small trees. The main damage is discolored foliage and premature needle cast. Trees are seldom killed directly.

### Lodgepole pine cone borer
### *Eucosma rescissoriana*

For the second year, 30% of the lodgepole pine cones collected at Mayer Lake Provincial Park were infested by the lodgepole pine cone borer, *Eucosma rescissoriana*. Additionally, 20% of cones at Pure Lake and 33% at Rennell Sound were infested. An average of 62% (range 43-75), 78% (range 33-100) and 70% (range 20-100) of seeds were destroyed at Mayer Lake Provincial Park, Pure Lake and Rennell Sound, respectively.

## HEMLOCK PESTS

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### Western blackheaded budworm,
### *Acleris gloverana*
### Hemlock sawfly,
### *Neodiprion tsugae*

Following three consecutive years of infestation, the area of western hemlock on the Queen Charlotte Islands defoliated by western blackheaded budworm and hemlock sawfly declined to an estimated 7360 ha in 1988 from 14 110 ha in 1987 (Table 8, Map 2). On northern Vancouver Island the area of western hemlock defoliated by western blackheaded budworm expanded to 4830 ha from 5 ha in 1987, the first year of recorded defoliation.

Maps detailing areas of 1988 defoliation on the Queen Charlotte Islands were provided by the British Columbia Forest Service with cooperation from Fletcher Challenge Canada and MacMillan Bloedel Ltd. Compilation and analysis was completed by FIDS at the Pacific Forestry Centre. Assistance with transportation from the above is also acknowledged.

Queen Charlotte Islands

Current defoliation was in areas similar to those affected in 1987 including Masset Inlet, southern Graham Island and northern Moresby Island*. Defoliation intensities declined, with the area of severe defoliation decreasing nearly fourteenfold from 1987 at two areas on the south side of Masset Inlet; 97% of the area defoliated was classified as light or moderate, down from 81% in 1987. More than half the stands defoliated were 20 to 100 years old, 35% were more than 100 years old and the remainder less than 20 years old.

*Defoliation on the Moresby archipelago was not significant.

Table 8. Area and intensity of defoliation of western hemlock by hemlock sawfly and western blackheaded budworm, as determined from aerial surveys on the Queen Charlotte Islands, 1985-1988.

| Defoliation intensity | Area defoliated (ha) | | | | Area defoliated in 1988 by stand age (ha) | | |
|---|---|---|---|---|---|---|---|
| | 1985 | 1986 | 1987 | **1988** | <20 yrs. | 20-100 yrs. | >100 yrs. |
| Light | 5 700 | 15 350 | 2 890 | **4 960** | 600 | 3 660 | 700 |
| Moderate | 19 100 | 22 800 | 8 630 | **2 210** | 90 | 260 | 1 860 |
| Severe | 3 800 | 6 150 | 2 590 | **190** | 0 | 190 | 0 |
| Total | 28 600 | 44 300 | 14 110 | **7 360** | 690 | 4 110 | 2 560 |

The decline in sawfly populations from 1987, based on larvae in standard FIDS three-tree beating samples, was 57% at Masset Inlet, 67% on southern Graham Island and 72% on northern Moresby Island. On southern Graham Island the number of sawfly larvae declined at one site to 410 in 1988 from 1650 in 1986. There were no larvae in five of nine samples on northwestern Graham Island from Naden Harbour to Eden Lake. At the remainder an average of 27 (range 3 to 85) sawfly larvae were collected.

Blackheaded budworm populations were most numerous (260 larvae per standard FIDS sample) at Tow Hill in Naikoon Provincial Park, where western hemlock over 10 ha were moderately defoliated. Budworm larvae were also numerous on Begbie Peninsula and Harrison Island in the Masset Inlet area, but defoliation of hemlock was attributed to sawfly populations.

Budworm populations declined to 40 larvae per standard FIDS three-tree beating sample in 1988 from 3150 in 1986 at the site southern Graham Island. Only one budworm larvae was collected on northwestern Graham Island. Elsewhere budworm population declined by 97%, 88%, and 99% at Masset Inlet, Graham Island and Moresby Island, respectively.

Adult sawfly survival was generally low on the Queen Charlotte Islands based on cocoon samples from 13 sites. Adults emerged from an average of only 13% of the cocoons (range 0 to 40%); the highest survival rate was on Harrison Island. An average of 34% of the sawfly cocoons were killed by Ichneumonidae parasites; the highest incidence (70%) was at Skidegate Narrows on Moresby Island. On this basis, defoliation of western hemlock on the Islands by hemlock sawfly and blackheaded budworm in 1989 is expected to further decline.

Vancouver Island

Defoliation of western hemlock of all age classes expanded to 4830 ha near Holberg on northern Vancouver Island.

Defoliation was light over 2690 ha in 80 separate pockets and moderate in one area over 2140 ha. The defoliated stands were from William Lake east to Nahwitti Lake and south to Glerup Creek on the southern shore of Holberg Inlet; small scattered infestations occurred in Cape Scott Provincial Park.

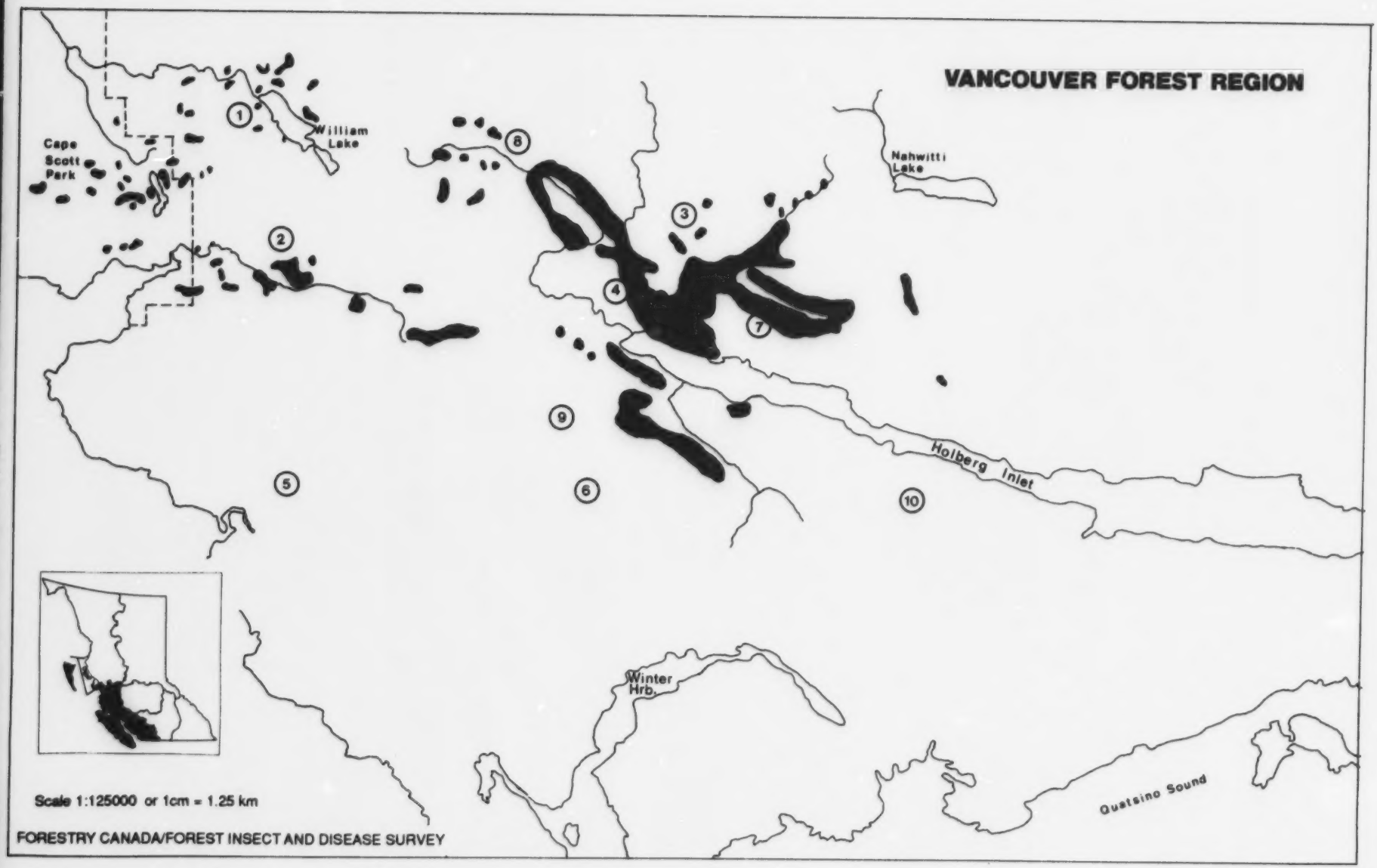
Egg sampling at ten sites (Table 9) adjacent to recently defoliated stands found an average of 59 eggs (range 4 to 166) per 45-cm branch sample which indicates mostly moderate or severe defoliation in 1989 (Map 4). The infestations will probably expand in both area and intensity in 1989, defoliating hemlock as far south as Quatsino Sound.

Assistance in obtaining the samples was provided by Western Forest Products.

Table 9. Location, average number of eggs per 45-cm branch in 1988, and predicted defoliation in 1989 by western blackheaded budworm on northern Vancouver Island, Vancouver Forest Region.

| Map # | Location | Avg. no. eggs per 45-cm branch 1988 | Predicted defoliation 1989** |
|---|---|---|---|
| ***1 | William Lake | 4 | trace |
| 2 | San Josef Main | 37 | moderate |
| 3 | NE 62 | 20 | light |
| 4 | Goodspeed River | 34 | moderate |
| ***5 | Ronning Creek | 28 | moderate |
| 6 | South Main | 84 | severe |
| 7 | NE Main | 166 | severe |
| ***8 | Stranby River | 33 | moderate |
| 9 | San Josef River | 133 | severe |
| ***10 | Hathaway Creek | 55 | moderate |
| Average | | 59.4 | |

** 1-5 eggs - trace defoliation
6-26 eggs - light defoliation
27-59 eggs - moderate defoliation
60+ eggs - severe defoliation




Map 4. Areas where western hemlock was defoliated by western blackheaded budworm and locations where eggs were sampled in 1988.

The last outbreak on Vancouver Island was from 1970 to 1973 when hemlock and amabilis fir were defoliated over 164 000 ha from Jordan river to Holberg. Previous outbreaks have resulted in mortality and dieback of some overmature hemlock, conditions that will be assessed during the course of this present outbreak. Twenty damage appraisal plots are to be established in March of 1989, ten plots in immature and ten in mature stands in the infestation areas.

### Western hemlock looper
### Lambdina fiscellaria lugubrosa

The western hemlock looper infestation at Jervis Inlet collapsed; no defoliation was recorded during aerial and ground surveys of the area and no larvae, pupae or adults were collected.

Mortality of immature to mature western hemlock and western red cedar was scattered throughout the 1987 infestation area with approximately 75 western hemlock and 25 western red cedar killed. The dead trees were either stressed by dwarf mistletoe, undergrown or partially shaded.

Recent drought conditions in the area may have contributed to the mortality. The cause of the collapse of the infestation is unknown; an abundant moth flight in September of 1987 indicated an increasing population. Previous outbreaks have collapsed due to high levels of egg and larval parasitism.

### Sirococcus shoot blight
### Sirococcus strobilinus

This shoot blight disease of western hemlock caused light to severe defoliation and tip dieback of immature trees throughout a large part of the host range in the Vancouver Region. Infected trees were noted in the north shore forests of Vancouver with light to moderate wilting and death of new shoots on 10% of 1- to 5-m high trees in the Capilano, Seymour, Coquitlam and Pitt Lake watersheds. The most severe infection was in 1- to 2-m high western hemlock along the San Josef River, west of Holberg where 20-100% of the new shoots (average 75%) on 60% of the trees over several hectares were infected. In suppressed western hemlock at Miracle Beach north of Courtenay, light branch dieback was recorded over 20 ha.

## TRUE FIR PESTS

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### Western balsam bark beetle-fungus complex
### Dryocoetes confusus
### Ceratocystis dryocoetidis

The balsam bark beetle in conjunction with the pathogenic fungus Ceratocystis dryocoetidis killed an estimated 9240 alpine fir over 470 ha compared to 10 450 trees over 420 ha in 1987 (Table 10). Tree mortality was recorded in the Fraser, Soo and Arrowsmith TSAs at 366, 90 and 14 ha, respectively.

Table 10. Location, area, number and volume of balsam trees recently killed by western balsam bark beetle-fungus complex determined from aerial surveys, Vancouver Forest Region, 1988.

| TSA and location | Area (ha) | Number of trees killed | Volume of host killed ($m^3$) |
|---|---|---|---|
| Fraser TSA | | | |
| Mowhokam Cr. | 105 | 2 100 | 2 300 |
| Log Cr. | 88 | 1 760 | 1 900 |
| Kookipi Cr. | 100 | 2 000 | 2 200 |
| Anderson River | 50 | 1 000 | 1 100 |
| Inkawthia Cr. | 15 | 300 | 400 |
| Sowaqua Cr. | 8 | 140 | 150 |
| Soo TSA | | | |
| Billygoat Cr. | 45 | 900 | 1 000 |
| Cayoosh Cr. | 10 | 200 | 200 |
| Haylmore Cr. | 30 | 500 | 600 |
| Sockeye Cr. | 5 | 80 | 90 |
| Arrowsmith TSA | | | |
| Museum Cr. | 14 | 260 | 280 |
| Total | 470 | 9 240 | 10 220 |

The beetle D. confusus and its associated blue stain fungus C. dryocoetidis, is common in mature high-elevation alpine fir stands in the province. Control at present is not feasible, although salvage logging will reduce actual timber loss.

### Fir engraver
### Scolytus ventralis

The fir engraver beetle was responsible for killing numerous grand fir in southwestern British Columbia. Prolonged summer droughts during 1985-87 have created serious water deficits which have stressed grand fir along the east coast of Vancouver Island, the Gulf Islands and the Sunshine Coast. The stressed trees, between 2- to 20-m high, have come under attack by the secondary bark beetle S. ventralis. The beetles were evident in approximately 65% of the trees examined. Periodic epidemics have caused extensive mortality, the last one in 1960-62 on the southern portion of Vancouver Island. The drought of the last few years may have enabled fir engraver beetle populations to build up to epidemic proportions.

### Balsam woolly adelgid
### *Adelges piceae*

Surveys to delineate the current distribution of the woolly adelgid continued in 1988. Intensified surveys were initiated after balsam woolly adelgid was found on West Thurlow Island in 1987, well north of the current regulation (quarantine boundary) zone. Spread of this pest appears static, and infestations remain inside the quarantine zone (except for Thurlow Island) after two years of intensive survey. The adelgid, or damage caused by the adelgid, was found at four of twelve locations sampled in 1988, all within the quarantine zone. Two of the positive samples were damage only, while the other two contained adelgids. Widespread patches of mature amabilis and grand fir on southern Vancouver Island have shown a general decline in healthiness, including some mortality, dead tops and sparse foliage. These symptoms may be a result of adelgid feeding.

Sampling for the adelgid will continue in 1989.

## SPRUCE PESTS

### Spruce beetle
### *Dendroctonus rufipennis*

The spruce beetle infested an estimated 5% of the Engelmann spruce over 84 ha in Manning Park. Six infestations were located in the Upper Tulameen River, Hubbard Creek and Holding Creek drainages, and have been active for approximately three years. These areas were excluded from the FIDS 86-6 annual Vancouver Report in 1987 because recent boundary changes in Manning Park had not been taken into consideration during aerial surveys but were mentioned in the Kamloops Report. Due to the inaccessibility of infestations, ground surveys were not carried out in 1988.

### Spruce weevil
### *Pissodes strobi*

Spruce weevil caused an average 32% leader mortality of 2- to 10-m Sitka spruce at 13 locations in the Vancouver Region in 1988 (Table 11). At 12 locations on Vancouver Island attacks ranged from 5% to more than 50% (average 33%). The most severe leader mortality occurred in five plantations surveyed by the B.C. Forest Service on the northwest coast of Vancouver Island, where weevil attacks exceeded 50% at all sites.

Table 11. Location and percent of spruce weevil attack in Sitka spruce stands, Vancouver Island, Vancouver Forest Region, 1988.

| Location | Total percent of trees attacked |
|---|---|
| Waukwaas Cr. | 5 |
| Port Alice | 5 |
| MacMillan Bloedel (Port Alice demo. forest) | 20 |
| Kennedy R. (Tofino) | 5 |
| Port Renfrew | 5 |
| Duncan Bay | 50 |
| Carnation Cr. | 50 |
| Bella Coola | 28 |
| Nootka I. | 50+ |
| Kauwinch R. | 50+ |
| Kaouk R. | 50+ |
| Port Eliza | 50+ |
| Union I. | 50+ |
| Average | 32 |

There is potential for a reduction of merchantable timber at rotation age due to crook, stem decay and other deformities resulting from weevil attack. Surveys of spruce stands will continue in 1989.

**Spruce aphid**
**Elatobium abietinum**

Defoliation of spruce trees by the spruce aphid continued at 1987 levels on Vancouver Island and Vancouver Mainland but decreased on the Queen Charlotte Islands in 1988. The reason for the decline is not known.

In the southern portion of the region defoliation of native and ornamental spruce was recorded at scattered sites form Port Hardy to Hope. Damage was most severe on ornamentals with up to 100% loss of old needles. Both incidence and intensity of feeding by the spruce adelgid were assessed in two plantations on the Queen Charlotte Islands.

In a 5-year-old stand at Skijump Creek, 82% of the new growth was lightly defoliated and 6% moderately defoliated. The old foliage at this site suffered 40% light to moderate defoliation and 60% severe defoliation. At Miller Creek in an 11-year-old stand, only 8% of the new growth was lightly defoliated and 100% of the old suffered light to moderate defoliation.

At Skijump Creek there was little change in the amount of defoliation of new growth from 1987 to 1988. In all other cases, defoliation of old foliage at Skijump Creek and new and old foliage at Miller Creek was considerably reduced from 1987 levels.

In a mature Sitka spruce stand near Miller Creek, trees marked in a 1982 impact assessment plot were again re-examined. The accumulated mortality of these trees due to defoliation by the spruce adelgid remained at the 1985 level of 67%.

The intensity of defoliation in 1989 will probably again be dependent on climatic factors, particularly the length and severity of winter cold spells.

### Spruce needle cast
### *Lirula macrospora*

The characteristic dieback of 2-year-old Sitka spruce foliage caused by *Lirula macrospora* was widespread on the Queen Charlotte Islands at intensities ranging from light to severe. Infections were noted on northern Moresby Island, particularly near Skidegate Lake, on regeneration and in the area from Honna River to Yakoun River on central Graham Island.

### Cone and seed pests

Cone and seed pests infested an average 2.7% (range 1-5%) of the Sitka spruce cones at three locations on the Queen Charlotte Islands in 1988.

A cone midge, Cecidomyiidae, infested less than 1% of the cones at Copper Bay; the fir coneworm, *Dioryctria abietivorella*, infested 2% of the cones at Lawn Point and 5% of the cones were infested at Yakoun River by the spruce cone maggot, *Strobilomyia neanthracinum*.

## CEDAR PESTS

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### Redwood bark beetle
### *Phloeosinus sequoiae*

The redwood bark beetle attacked drought-stressed western red cedar over a wide area in southwestern portions of the region. This secondary beetle caused mortality and top-kill on mostly pole-sized western red cedar along the eastern coast of Vancouver Island from Campbell River to Victoria, on the Sunshine Coast from Powell River to Gibsons Landing and the Gulf Islands. Many of these trees may have died from drought regardless of beetle attack. The redwood bark beetle frequently attacks and kills western red cedar on poor sites. Populations may have built up so that, even if the drought subsides, attacks will continue in 1989.

### A gall midge
### *Contarinia* n. sp.

The incidence of gall midge damage increased dramatically on yellow cedar (*Chamaecyparis nootkatensis*) at a Vancouver Island seed orchard. An average of 15% of the tips, including vegetative growth as well as male and female reproductive structures were damaged, compared to an average of 2% in 1987. At Saanichton seed orchard all of the yellow cedar trees were infested with the midge. This new species was first found in 1987 by FIDS staff at three seed orchards on Vancouver Island. Subsequent surveys have confirmed that the midge occurs throughout the host range in British Columbia.

Feeding by the gall midge larva causes twisting of new shoots and galling of terminal growth on branches. Galled twigs die back to the nearest crotch. FIDS staff are currently studying the biology and damage of this pest; monitoring will continue in 1989.

## MULTIPLE HOST PESTS

### Pests of young stands

Twenty-one young stands, both planted and natural, were examined by FIDS in the Vancouver Forest Region using a fixed-radius plot system to identify and quantify pest problems. Important pests found during these surveys have been summarized in Table 12. A more detailed description has been compiled as an appendix to this report and is available upon request.

Table 12. Summary of pests of young stands, Vancouver Forest Region, 1988.

| Host | Stand[1] | Pest | No. of stands | Average percent trees affected | Range | Remarks |
|---|---|---|---|---|---|---|
| Douglas-fir | 8 | Adelges cooleyi | 7 | 60 | 4-100 | trace to severe discoloration of needles |
| | | deer browse | 3 | 6 | 2-16 | severe stripping of new growth |
| Hybrid poplar | 4 | Mycosphaerella populorum | 1 | 22 | - | perennial cankers on 20% of trees |
| | | Phyllonorycter sp. | 2 | 24 | 10-40 | on average 20% of leaves mined |
| Lodgepole pine | 3 | Zellaria haimbachi | 2 | 16 | 6-47 | light defoliation of current year's foliage |
| | | Hypodermella concolor | 2 | 18 | 2-20 | light-moderate defoliation |
| | | Endocronartium harknessii | 1 | 2 | - | severe infection of branches and light infection of stems |
| Amabilis fir | 3 | deer browse | 1 | 11 | - | moderate stripping of new growth |
| Grand fir | 2 | deer browse | 1 | 23 | - | severe stripping of new growth |

| Host | Stand[1] | Pest | No. of stands | Average percent trees affected | Range | Remarks |
|---|---|---|---|---|---|---|
| Western red cedar | 2 | deer browse | 1 | 16 | - | severe stripping of new growth |
| Engelmann spruce | 2 | Adelges cooleyi | 1 | 83 | - | moderate galling of branches |
| | | Hylobius warreni | 1 | 8 | - | infested trees recently killed |
| Mountain hemlock | 1 | Sirococcus strobilinus | 1 | 10 | - | moderate infection of new twigs |

[1]Number of surveyed stands in which tree species comprised more than 20% of stand.

Deer was the most damaging pest encountered in young Douglas-fir stands. Severe stripping of new growth was observed on an average of 6% of the trees in three of eight stands. The spruce gall adelgid, Adelges cooleyi, was the most common pest, infesting seven of eight stands but causing little significant damage.

The leafminer, Phyllonorycter sp., was responsible for premature leaf drop on 24% of the poplar saplings in two of four plantations. The fungus, Mycosphaerella populorum, caused stem and branch cankers on 22% of the hybrid poplars at one of four stands examined.

Pine needle sheathminer, Zellaria haimbachi, was the most prevalent pest of lodgepole pine, lightly defoliating an average 16% of the trees. The needle cast, Hypodermella concolor and the western gall rust, Endocronartium harknessii, infected an average 16% and 2% of the young lodgepole pine, respectively. Western gall rust will eventually kill the trees while the Hypodermella needle cast reduces tree growth.

Feeding by deer was the most serious problem in young amabilis fir, grand fir and western red cedar stands. Ungulates feed upon an average 19% of the new growth on 16% of the trees in three of seven stands.

Root collar weevil, Hylobius warreni, killed 8% of the trees in one of two Engelmann spruce stands surveyed. A. cooleyi was seen forming branch tip galls on 100% of the Sitka spruce and 84% of the Engelmann spruce in two of three stands.

The shoot blight, Sirococcus strobilinus, moderately infested 10% of the trees in the only mountain hemlock stand surveyed.

## Gypsy moth
## *Lymantria dispar*

Gypsy moth pheromone-baited sticky traps to attract male moths were placed at 97 locations by the Forest Insect and Disease Survey in provincial and municipal parks throughout the Vancouver Region. A total of seven gypsy moths were trapped in the region by Agriculture Canada; three were on Vancouver Island and four on the Mainland (Table 13), compared with the 23 gypsy moths trapped in the Vancouver Region in 1987.

Table 13. Locations where adult male gypsy moths were trapped in sticky traps baited with sex pheromones in the Vancouver Region, 1988.

| Location | No. moths | No. traps |
|---|---|---|
| CFB Colwood | 1 | 1 |
| Parksville | 2 | 2 |
| Point Roberts | 2 | 1 |
| Coquitlam | 1 | 1 |
| West Vancouver | 1 | 1 |
| Total | 7 | 6 |

This is the third consecutive year that moths have been caught at CFB Colwood and the second consecutive year at Parksville. The catches at Point Roberts, Coquitlam and West Vancouver were all new. At least one new egg mass was found at Point Roberts. To date, populations have not become established in British Columbia and defoliation has not been observed. The major concern of the forestry sector continues to be quarantine restrictions such as those in force during 1985 in parts of Oregon.

Approximately 8000 sticky traps were monitored throughout British Columbia in the thirteenth year of a cooperative program with Agriculture Canada (Plant Health), B.C. Ministry of Forests, and FIDS, Forestry Canada. A total of 12 moths were caught across British Columbia this year compared with 216 moths in 1987. Following catches of more than 200 male moths and detection of new egg masses in 1987, three aerial and partial ground applications of *Bacillus thuringiensis* were completed by Agriculture Canada in May and June 1988 in parts of Kelowna and Colwood with ground-based sprays at Parksville. The *B.t.* was applied "neat" at 30 BIU/ha over 112, 40 and 4.5 ha, respectively, from April 27 to June 14. The above trapping results indicate successful control.

## Root collar weevil
## *Steremnius carinatus*

The root collar weevil caused moderate levels of mortality of recently planted western hemlock, Douglas-fir and western red cedar seedlings at two locations on the west coast of Vancouver Island. Surveys by MacMillan Bloedel Ltd. personnel at Walbran Creek and Carmanah Creek showed 20-50% (avg. 30%) mortality in scattered patches over two plantations of 100 ha each. These are

slightly higher levels than those found by the Forest Insect and Disease Survey in 1984 and 1985, when an average 15% and 5% of the seedlings were girdled respectively, in plantations from San Mateo Bay to Holberg. The seedling weevil was considered a scavenger until 1961, when it was recognized as a pest of coniferous plantations and natural regeneration in coastal British Columbia. In the spring or autumn, indication of weevil numbers on a particular site may be obtained by trapping. In potential weevil areas, spring rather than fall planting, especially of young stock, is advantageous because this allows a season of growth before exposure to autumn feeding.

Mortality is expected to continue in 1989 and further surveys will be conducted.

### Drought

Mortality and top-kill of individual and small groups of immature and semimature western red cedar, western hemlock and grand fir were widespread in the coastal areas of the Vancouver Region. Affected trees range in height from 2-20 m with typical symptoms including either red foliage or a shedding of their entire complement of green needles. Discoloration on cedar begins in the crown and gradually proceeds to the base. Prolonged summer droughts during 1985-87 have created serious water shortages, especially on shallow exposed sites. Well-established mature trees do not appear to be affected; neither do the more drought-resistant species such as Douglas-fir, arbutus, Garry oak and shore pine. At Victoria, precipitation during the growing seasons (April-September) of 1985-87 was 25% below the 30-year norm.

Root rot fungi were not evident in any of the trees examined. The majority of grand fir and western red cedar surveyed were attacked by the secondary bark beetles, Scolytus ventralis and Phloeosinus sequoiae, respectively. Both species commonly attack recently dead or severely stressed trees. No secondary beetles were evident on western hemlock.

If dry conditions prevail in 1989, surviving drought-stressed pole-sized or smaller grand fir, western red cedar and western hemlock could be at risk.

## DECIDUOUS TREE PESTS

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### Satin moth
### Leucoma salicis

The satin moth, an introduced defoliator, in conjunction with the forest tent caterpillar severely defoliated exotic poplar over approximately 200 ha on the northeastern slopes of Mt. Thurston southeast of Chilliwack. Light defoliation was also noted on boulevard Lombardy poplar in and around Harrison Hot Springs; only satin moth larvae were collected at this location.

The forest tent caterpillar is not usually active in southwestern British Columbia but the western tent caterpillar is common and has caused severe defoliation of deciduous trees over the last several years.

Both insect populations were heavily infected (90% of the larvae) by a nuclear polyhedrosis virus when surveyed in June. The prevalence of the disease

in the population indicates that 1988 is not the first year of the infestation; the infestation is expected to collapse in 1989 due to NPV. Light defoliation has little effect on tree growth. Two or more years of moderate-to-severe defoliation, however, causes a severe reduction in radial growth and may cause considerable branch and twig mortality. Usually, as was the case this year, little tree mortality is caused by satin moth defoliation as the trees refoliate and create enough foliage to carry on photosynthesis. Periodic, localized outbreaks have occurred on Vancouver Island and the southern interior from 1921 to 1983. Although the satin moth is primarily a pest of shade, park or windbreak trees, native stands of trembling aspen and black cottonwood have been severely defoliated and limited top-kill and tree mortality have occurred.

### Forest tent caterpillar
### *Malacosoma disstria*

The forest tent caterpillar was active in two diverse areas of the Vancouver Forest Region, Bella Coola and Chilliwack. In the Bella Coola area the tent caterpillar lightly to severely defoliated 100% of the deciduous trees and shrubs from Stuie to Bella Coola. The most severe defoliation, 60-100%, occurred near Hagensborg.

The Chilliwack infestation occurred in conjunction with the satin moth, *Leucoma salicis*. These two pests severely defoliated exotic poplar over 200 ha on the northeastern slopes of Mt. Thurston. Disease and/or virus was prevalent in the tent caterpillar population at Chilliwack, indicating decreased population for 1989.

### Western tent caterpillar
### *Malacosoma californicum pluviale*

Populations of this colonial defoliator have declined to endemic levels after four consecutive years of severe defoliation. Scattered individual colonies were visible throughout the region on deciduous trees and shrubs. Through egg mass counts in 1987, it was predicted that due to a virus and/or disease, populations could decline in 1988. The average number of new egg masses per tree at four locations in 1988 was 0.25 compared to 4.25/tree in 1987. Larvae examined during the spring of 1987 at several locations showed evidence of disease in the population. Dry shriveled immature larvae were observed on the tent webbing and mature larvae were hanging from leaves and branches indicating a diseased population. Populations are expected to remain at endemic levels in 1989.

### Winter moth
### *Operophthera brumata*

Although defoliation by the winter moth continued for the eighteenth consecutive year throughout southeastern Vancouver Island. Damage was very light, mainly on Garry oak, shrubs and fruit trees. Populations remained low in areas where defoliation had been severe in the past.

The significant decline in winter moth populations over the last several years can be attributed in part to the release of more than 300 000 parasites (*Cyzenis albicans* and *Agrypon flaveolatum*) which were released during 1979-1981. Continued monitoring of populations is planned for 1989.

### Western winter moth
### *Erannis tiliaria vancouverensis*

The western winter moth defoliated an estimated 110 ha of vine and broadleaf maples throughout Sasquatch Park north of Harrison Hot Springs. Scattered widespread defoliation of alder, willow and maple was also noted in the Skagit Valley, Alexandria Park, Gilt Creek, Anderson River and North Bend areas. In Sasquatch Park severe defoliation up to 100% was noted on understory vine maple along Deer Lake but decreased to light (less than 5%) at Harrison Lake at the western end of the park. Larval feeding started on the understory broadleaf maple. The last infestation was recorded in 1972 at Railroad Creek; infestations are usually of short duration.

### Alder sawfly
### *Hemichroa crocea*

The alder sawfly caused light to moderate defoliation of red alder throughout the eastern half of Graham Island and in central and northwestern Moresby Island. The majority of defoliation occurred late in the season, possibly due to a second generation of sawfly larvae. The last significant defoliation due to the sawfly occurred in the 1983 and 1984 seasons over similar areas.

### Dogwood leaf blight
### *Gloeosporium* sp.

This leaf blight continued to cause defoliation of western flowering dogwood in 1988 but at a reduced level from 1987. As in past years, infection was widespread, causing an average 15% defoliation of affected trees from Yale to Powell River on the mainland and from Victoria to Port Alberni on Vancouver Island.

No new mortality was noted at either Harrison Lake or the Sunshine Coast where mortality was noted in 1987. This lack of mortality is partly due to the relatively dry spring and summer of 1987 and 1988. The mortality noted in 1987 was due to the accumulated effects of previous infections. Wet spring and summer weather conditions in 1989 could facilitate the spread of the fungus. It is believed the disease extends throughout the host range and further sampling will be conducted in 1989 to confirm this.

## SPECIAL SURVEYS

### Seed orchards

Thirteen seed orchards in the Vancouver Region were surveyed two or more times during 1988 for early detection of insects, diseases and abiotic damage as well as damage assessments, discussion of management options and transfer of technical information. During these surveys, numerous insects, diseases and other problems were recorded.

Major insects and diseases are listed in Table 14. A complete detailed list of all pests has been compiled as an appendix to this report and is available upon request.

Surveys will continue in 1989 and significant problems will be reported as noted at that time.

Table 14. Major insects and diseases in seed orchards of the Vancouver Region, 1988.

| Host | No. of orchards surveyed | Pest | Frequency | Average percent trees or cones affected | Percent Range | Severity |
|---|---|---|---|---|---|---|
| D-fir | 11 | Cooley spruce gall adelgid, *Adelges cooleyi* | 7 | 69 | 2-100 | light to severe |
| | | Fir coneworm, *Dioryctria abietivorella* | 4 | 24 | 5-80 | light to severe |
| wH | 9 | Western spruce budworm, *Choristoneura occidentalis* | 3 | 7 | 1-14 | light to moderate |
| | | Hemlock woolly adelgid, *Adelges tsugae* | 1 | 14 | 14 | moderate |
| wrC | 2 | A cone midge, *Mayetiola thujae* | 1 | 25 | 25 | moderate |
| sS | 5 | Cooley spruce gall adelgid, *Adelges cooleyi* | 2 | 62 | 25-100 | moderate to severe |
| yC | 2 | A gall midge, *Contarinia* n. sp. | 1 | 100 | 100 | severe |
| aF | 3 | Balsam woolly adelgid, *Adelges piceae* | 2 | 15 | 5-24 | light to moderate |

D--fir - Douglas-fir
wrC - western red cedar
yC - yellow cedar
wH - western hemlock
sS - Sitka spruce
aF - Alpine fir

The Cooley spruce gall adelgid, *Adelges cooleyi*, lightly to severely infested an average of 69% (range 25-100%) of the Douglas-fir at seven of the eleven locations where Douglas-fir is cultivated. The most severe infestation was noted at Surrey, where 100% of the trees were severely infested. At four locations the fir coneworm, *Dioryctria abietivorella*, lightly to severely infested an average of 24% (range 5-80%) of the Douglas-fir cones examined.

The western spruce budworm, *Choristoneura occidentalis*, lightly infested an average of 7% of the western hemlock at three of the nine orchards examined, while the hemlock woolly adelgid, *Adelges tsugae*, moderately infested 14% of the hemlock trees at only one location.

A cone midge, Mayetiola thujae, moderately infested 25% of the western red cedar at one of two orchards.

The Cooley spruce gall adelgid, Adelges cooleyi moderately to severely infested an average of 62% (range 25-100%) of the Sitka spruce at two of five orchards surveyed.

A new species of gall midge, Contarinia n. sp. severely infested 100% of the yellow cedar at one of the two locations which cultivate yellow cedar.

The Balsam woolly adelgid, Adelges piceae, moderately infested 20% of the amabilis fir at two of three orchards surveyed.

**Acid rain plots**

The ten ARNEWS (Acid Rain National Early Warning System) study plots in the Vancouver Region were visited several times each during 1988, as has happened since 1984. Acid rain symptoms (damage to vegetation that cannot be diagnosed as biotic or abiotic) and numerous insects and diseases were recorded at nine plots (Table 15). The acid rain symptoms may or may not be caused by atmospheric pollutants. The canker Ciboria sp. on vine maple at the East Seymour plot was a new host record.

Table 15. Pest problems and possible pollution damage observed at and in the vicinity of ARNEWS plots in the Vancouver Region, 1988.

| Plot/Location | Pest/Other symptoms | Host[1] | % trees affected | Intensity |
|---|---|---|---|---|
| #901 | Durandiella pseudotsugae | D-fir | 50 | moderate |
| Shawnigan | Synanthedon novaroensis | D-fir | 1 | light |
| | Chlorosis of 3- and 4-year-old needles | D-fir | 5 | light |
| #902 | Coleotechnites sp. | wH | 2 | light |
| U.B.C. | Sirococcus strobilinus | wH | 15 | moderate |
| (Research Forest) | Operophtera bruceata | aL | 60 | light |
| | Chlorotic needles & branches* | wH | 16 | moderate |
| #903 | Polyporus schweinitzii | D-fir | 5 | light |
| Saltspring Island | | | | |
| #904 | Phaeocryptopus gaeumannii | D-fir | 10 | light |
| Campbell River | Endocronartium harknessii | lP | 90 | light |
| #910 | Epipolaeum tsugae | wH | 10 | severe |
| Capilano | Sirococcus strobilinus | | 10 | severe |
| | Interveinal necrosis** | aL | 15 | light |
| | Chlorosis of needles | aF | 5 | moderate |
| | Needle dwarfing (fume damage?) | | | |
| | Pseudohylesinus grandis | aF | 15 | light |
| | Chlorotic branches* | wH | 6 | light |

| Plot/Location | Pest/Other symptoms | Host[1] | % trees affected | Intensity |
|---|---|---|---|---|
| #911 Seymour East | Ciboria sp. (canker) | M | 2 | light |
| #912 Seymour Mainline | Phomopsis sp. | wrC | 100 | moderate |
| | Chlorotic branches* | wH | 25 | light |
| #913 Coquitlam 910 | Speckling on leaf (ozone) | B | 6 | light |
| | Chlorotic branches* | wH | 100 | light |
| #914 Coquitlam West | Septoria alni Marginal necrosis*** | aL Cascara | 22 | moderate |

[1]aF - amabilis fir; aL - alder; B - birch; D-fir - Douglas-fir; lP - lodgepole pine; M - maple; wH - western hemlock; wrC - western red cedar.

*Mimics damage by heavy metal emissions, refer to Figures 19, 20, 31 Spruce, ARNEWS Symptomology Manual.
**See Figures 01, 03 Alder, ARNEWS Symptomology Manual, Hydrocarbon damage.
***See Figure 08 Aspen, ARNEWS Symptomology Manual.

These plots are part of a national system to gather baseline data on acid rain in Canada's forests. The data is needed to clearly and accurately detect early signs of acid rain damage and to annually monitor for changes in forest conditions.

**Fume damage**

Foliage discoloration covering an estimated 34 ha and previously noted cumulative damage, i.e. dead snags over 300 ha, were visible near the Port Alice pulp mill during aerial surveys in 1988. Ground surveys revealed 60% of the western hemlock were affected. The symptoms include shortened needles which were 1/2 to 1/3 the size of normal needles, very little (50%) bud flush, small buds, sparse foliage, and red and chlorotic needles. Symptoms were apparent in widespread scattered patches within 6 km of the mill. Several fume damage plots in the Port Alice area have been established by the BCFS in conjunction with the Ministry of Environment. Foliage samples from these plots were collected in September and will be analyzed for terpene composition and sulphur content. FIDS will continue to monitor the fume damage site and surrounding areas in 1989.

## MINOR PESTS

Collections and records were made of many pests currently at endemic levels (Table 16). These pests include Swiss needle cast, western gall rust, Cooley spruce gall adelgid, fall webworm, and other insects and diseases.

Table 17. Pests currently at endemic levels, Vancouver Forest Region, 1988.

| Pest | Host* | Location | Damage | Status |
|---|---|---|---|---|
| Douglas-fir tussock moth, Orgyia pseudotsugata | D-fir | Vancouver Region | none | endemic |
| Green-striped forest looper, Melanolophia imitata | D-fir | Lower Mainland | 3 larvae collected per location on 9% of trees | endemic |
| Phantom hemlock looper, Nepytia phantasmaria | D-fir | Lower Mainland | low numbers of larvae collected at Hope | endemic |
| Pine butterfly, Neophasia menapia | D-fir | Vancouver Region | none | endemic |
| Silver spotted tiger moth, Lophocampa argentata | D-fir | Vancouver/ Sunshine Coast | occasional scattered colonies, caused light defoliation | static |
| Swiss needle cast, Phaeocryptopus gaeumannii | D-fir | Vancouver Region | small scattered areas throughout region, up to 50% defoliation at Golden Ears Park | endemic |
| Western gall rust, Endocronartium harknessii | lP | Vancouver Region | infection as high as 90% in scattered areas | endemic |
| Animal damage (deer) | sS<br>wH<br>wrC | QCI | moderate levels at widespread locations | endemic |
| Cooley spruce gall adelgid, Adelges cooleyi | sS<br>D-fir | Vancouver Region | light-moderate galling on spruce, needle discoloration on D-fir at widespread locations throughout the region | static |
| A gall adelgid, Pineus sp. | sS | QCI | trace at two plantations | static |

| Pest | Host* | Location | Damage | Status |
|---|---|---|---|---|
| Spruce budmoth, *Zeiraphera* sp. | sS D-fir aF | Vancouver I. QCI | light defoliation in scattered patches on the west coast and QCI | endemic |
| Spruce bud necrosis | sS | QCI | widespread light intensities, unknown causes | increasing |
| Spruce needle casts, *Lophodermium piceae* | sS | QCI | low levels at one location | static |
| *Rhizosphaera pini* | sS | " | " | " |
| Spruce needle rust, *Chrysomyxa ledi* | sS | QCI | light infection at two locations | endemic |
| *Chrysomyxa ledicola* | sS | QCI | severe infection of current growth on trees in bogs | endemic |
| Twig dieback, *Sirococcus strobilinus* | sS | QCI | low levels at one location | endemic |
| Dwarf mistletoe, *Arceuthobium tsugense* | wH | QCI | widespread | endemic |
| Green velvet looper, *Epirrita autumnata* | wH | Vancouver I. | individual collections made at scattered locations | endemic |
| Hemlock sawfly, *Neodiprion* sp. | wH D-fir | Vancouver Region | common widespread low levels of defoliation | endemic |
| Leaf blight, *Marssonina* sp. | rA | QCI | widespread foliar disease | endemic |
| Leaf spot, *Septoria alni* | rA | QCI | widespread light levels | endemic |
| Bruce spanworm, *Operophtera bruceata* | Deciduous | Vancouver Region | low levels of infestations at | endemic |
| Cypress tip moth, *Argyresthia* spp. | Ornamental juniper, cedar and cypress | Vancouver I. | light foliage damage at several widespread locations | static |

| Pest | Host* | Location | Damage | Status |
|---|---|---|---|---|
| Fall webworm, *Hyphantria cunea* | Deciduous trees and shrubs | Vancouver Region | occasional scattered webbing throughout region | endemic |
| Beaver | conifers | QCI | localized flooding | endemic |
| Cedar leaf blight, *Didymascella thujina* | wrC | Vancouver Region | light infections in most areas of the region; damage is rarely serious | static |
| Larch sawfly, *Pristiphora erichsonii* | wL | Lower Mainland | scattered light defoliation at UBC Research Forest | increasing |
| Hard pine adelgid, *Pineus coloradensis* | wwP | QCI | trace level at one plantation | increasing |
| Balsam twig aphid, *Mindarus abietinus* | aF<br>gF | Vancouver I. | high numbers of adults collected at three locations | endemic |

*D-fir - Douglas-fir; wH - western hemlock; aF - amabilis fir; gF - grand fir; sS - Sitka spruce; wrC - western red cedar; wL - western larch; wwP - western white pine; rA - red alder, lP - lodgepole pine

**NEW RECORDS OF OCCURRENCE AND DISTRIBUTION**
**Vancouver Forest Region, 1988**

| | |
|---|---|
| | **Coniferous Hosts** |
| **Pine, Scots** | |
| Cenangium ferruginosum<br>Canker fungus | New host record. On recently dead twigs at Sidney. |
| **Douglas-fir** | |
| Epicoccum nigrum<br>An epiphyte | New host record, at Langley. |
| **Spruce, Sitka** | |
| Adelges cooleyi<br>Cooley spruce gall adelgid | New regional record galling cones, at Saanichton. |
| Cladosporium herbarum<br>Saprophyte | New host record, at Queen Charlotte City. |
| Mindarus obliquus<br>Spruce twig aphid | New regional record on cones, at Saanichton. |
| Oligonychus ununguis<br>Spruce spider mite | New regional record on cones, at Saanichton. |
| **Fir, amabilis** | |
| Phoma sp.<br>Dieback fungus | New host record, at Victoria; probably secondary. |
| Pleroneura sp.<br>Shootboring sawfly | New regional record from south coast at Holberg. Also collected for the first time in more than 15 years from interior at Creston. |
| Sydowia semenospora<br>Dieback and canker fungus | New regional record at Caycuse, Honeymoon Bay. |
| **Fir, grand** | |
| Trisetacus grosmanni<br>Eriophyiid mite | New regional record on male buds at Duncan. |
| **Redwood** | |
| Phoma sp.<br>Dieback fungus | New host record, at Victoria. |

## Non-coniferous Hosts

**Alder**

| | |
|---|---|
| Phomopsis sp.<br>Dieback fungus | New host record, at Victoria. |
| Seimatosporium sp.<br>Saprophyte | New host record, at Rosedale. |

**Alder, red**

| | |
|---|---|
| Eriocraniidae<br>Alder leafminer | New regional record at Victoria, Sidney and Vancouver; mining leaves early in season. |
| Marssonina sp.<br>Leaf blight | New host record, at Sandspit. |

**Apple, crabapple**

| | |
|---|---|
| Yponomeuta padella<br>Ermine moth | New regional distribution record outside Lower Mainland, at Mt. Currie near Pemberton. |
| Phyllonorycter blancardella<br>Spotted tentiform leafminer | New regional record, at Victoria, Sidney. |
| Podosphaera leucotricha<br>Mildew | First specimen on this host, at Campbell River. |

**Apple**

| | |
|---|---|
| Viscum album subsp. album<br>European mistletoe | First Canadian record, at Victoria. |

**Arbutus**

| | |
|---|---|
| Gloeosporium sp.<br>Leaf blight | New host record, at Powell River. |

**Aspen, trembling**

| | |
|---|---|
| Ectoedemia populella<br>Poplar petiole gall moth | New regional record, at Sidney. |

**Birch, white**

| | |
|---|---|
| Profenusa thomsoni<br>A birch leafminer | New record from coastal B.C., at Chilliwack. |
| Stigmina carpophila<br>Twig blight | First specimen on this host, at Powell River. |

| | |
|---|---|
| **Cottonwood, black** | |
| Dasineura, n. sp.<br>Bud gall midge | New regional record of new species, at Duncan and Sidney. |
| **Dogwood** | |
| Phoma sp.,<br>Dieback fungus | First specimen on this host, at Vancouver. |
| **Locust, black** | |
| Diaporthe eres,<br>Bark fungus | New regional record, affecting branches at Comox. |
| **Maple, sycamore** | |
| Mycosphaerella mycopappi<br>Leaf spot | New host record, at Rosedale. |
| **Maple, vine** | |
| Ciboria sp.<br>Canker fungus | New regional record, at North Vancouver. |
| **Oak** | |
| Bucculatrix ainsliella<br>Oak leaf skeletonizer | New distribution record outside Vancouver at Duncan and Surrey. |
| **Salal** | |
| Cameraria gaultheriella<br>Salal leafminer | New regional record, Victoria to Courtenay. |
| Dasyscyphus sp., Bark fungus | First specimen on this host, at Gold River. |
| Phacidium gaultheriae<br>Stem canker | First specimen on this host, at Galiano Island. |
| **Soil and duff** | |
| Agaricus semotus, Mushroom | New regional record, at Victoria. |
| Amanita smithiana, Mushroom | New regional record, at Colwood. |
| Boletus aestivalis, Mushroom | New regional record, at Victoria. |
| Cortinarius cotoneus group<br>Mushroom | New regional record, at Mesachie Lake. |
| Hydnotrya variiformis<br>Soil fungus | New regional record, associated with salal roots at Port Renfrew. |